

present species is the sole known representative in the European seas, thus (at least analogically) connects the Brachiopoda with the Conchifera through *Auomia*, the byssal plug of which has a similar excavating or eroding power (see 'British Conchology,' vol. ii. p. 32). Strong muriatic acid, subsequently diluted, produced only a partial effect on the shells of *D. atlantica* and *D. striata*, both of which contain a considerable portion of carbonate of lime, but are to a certain extent chitinous. *Crania* is entirely calcareous. Professor King and Mr. Davidson described *D. atlantica* as "corneous;" Dr. Carpenter says the shell of *D. lamellosa* is "horny;" and M. Gratiolet adds that *Discina* is composed of two layers, one "corné" and the other "calcaire." The outer or calcareous layer of *Discina* is, according to Gratiolet, permeated by minute caecal canals, and the inner or "corné" layer is imperforate; but I cannot help thinking that a further microscopic examination would be desirable. Otherwise it is difficult to conceive how there could be any connexion or communication between the vascular system of the body or animal and the outer layer of the shell, as exists in *Terebratula* and *Crania*. I cannot find any perforated or tubular structure in *D. striata*.

D. atlantica is probably the same species as the fossil from the Coralline Crag at Sutton, which Mr. S. Wood at first doubtfully named *D. norvegica*, and afterwards *D. fullens*; and which Mr. Davidson at first doubtfully named *Orbicula lamellosa*, and since *D. fallens* (see Ann. and Mag. Nat. Hist. 1840, and the Palæontographical Society's Publications for 1852 and 1874). But *Orbicula norvegica* of Sowerby (= *O. lamellosa*, Broderip) is a very different and tropical species of *Discina* (see also Trans. Linn. Soc. vol. xiii. p. 465, and the 'Malacological and Conchological Magazine,' 1838, pp. 19-23).

XXIII.—On the Structure of the Mouth in Sucking Crustacea.

By Professor J. C. SCHIÖDTE*.

[Continued from 'Annals,' 1868, 4th ser. vol. i. p. 25.]

II. ANTHURA. III. LAPHYSTIUS.

16. Next to Cymothoidæ, though as a type of a separate family, the genus *Anthura* must be placed.

The specimens which have served for the following examination belong to *Anthura carinata*, Kröyer (Naturh. Tidsskr.

* Translated and partly condensed, with the sanction of the author, from 'Naturhistorisk Tidsskrift,' 3rd ser. vol. x. Copenhagen, 1875, with five plates (explanations in Latin). The first part (Cymothoæ) was translated in the 'Annals,' 1868, 4th series, vol. i. pp. 1-25.

2nd ser. vol. ii. p. 402), which occurs not unfrequently in the Sound near Copenhagen*. Milne-Edwards, in his great work on Crustacea, was unable to give any information about the structure of the mouth; and Kröyer's attempt to decipher it was necessarily incomplete, on account of the great difficulties of the investigation, coupled with the circumstance that he had only two specimens at his disposal. He treats only of the mandibles and the maxillipeds; but his statements are upon the whole correct as far as they go and from his point of view. He has observed the serrulate lobe of the mandible, although of course he does not recognize it as an inner lobe. His statement that the "maxillary lobe" of the maxillipeds reaches to the apex of the palpus must be explained as founded on a confused appearance of the parts caused by pressure; but it shows at the same time how far he must have been from guessing that he had a mouth constructed for suction before him.

An entirely different standpoint is occupied by Messrs. Spence Bate and Westwood in their work on the British Sessile-eyed Crustacea, inasmuch as they unhesitatingly declare that the mouth in these Crustaceans "is evidently formed for suction." But their account of its structure is too short, and conceived in too general terms, to afford materials for solving the problem now before us—viz. to understand thoroughly the special construction and mode of action of each part of the mouth by itself, as well as the connexions and the

* It is still doubtful whether this really is a different species either from *A. gracilis*, Mont., or from *A. gracilis*, Milne-Edwards. According to the description given by Messrs. Spence Bate and Westwood ('History of British Sessile-eyed Crustacea,' ii. p. 160) of the original specimen in the British Museum, the only one which they have seen, this would differ from our species by a more slender form, the last tail-segment also having parallel sides, and its posterior margin being truncate and irregularly crenulated, like that of the branches of the limbs. But these differences are precisely such as might be owing to the fact of the specimen in question being a dried one. As for the *A. gracilis* of Milne-Edwards, his description and figure of the tail (Hist. des Crust. iii. p. 136, pl. 31. fig. 35) agree very well with our species. I observe that Messrs. Spence Bate and Westwood quote *A. gracilis*, Milne-Edwards, twice:—first (p. 160), as synonymous with *A. gracilis*, Mont., and again (pp. 165 and 167) where they refer it to their *Paranthura Costana*—a circumstance which seems to require an explanation, particularly because the latter animal has, according to these authors, a long tail with free segments, whilst Milne-Edwards describes and figures the tail of his *A. gracilis* as consisting of only two pieces, namely, besides the terminal segment, only one other, formed by the coalescence of several very short ones. In order to secure as far as possible the recognition of the species examined above, I have added figures of the tail as seen from the side, from above, and below, to those representing the head and the parts of the mouth.

harmonious cooperation of all the parts of the complicated machinery to one end, and, finally, to appreciate the fundamental types which may be discerned in the conformation of the mouth in these Crustaceans. These questions can be solved only by a well planned, gradually progressing dissection under the microscope, carried out in such wise that the *natural* position of each part is observed with certainty—a process difficult in itself, and involving the sacrifice of much time and many specimens. As I shall have no other convenient opportunity in the sequel for doing so, I shall here at once briefly indicate how I interpret the figures which the authors quoted have inserted in their page 165 (vol. ii.) as representing the parts of the mouth in *Paranthura Costana*, but which are not elucidated either by references in the text or by any special explanation.

There are two figures marked *f*, of which the one to the right no doubt represents one of the maxillipeds with its two-jointed palpus, its stipes and cardo, together with the prosteronum, though the relative proportion of these parts is not accurately rendered (an observation which may be made with regard to several figures in this very useful work, but which is accounted for by the consideration that the drawings evidently are mere sketches intended to assist the student in finding the parts). The other figure *f* represents, as I believe, the terminal portion of the same organ. The letter *e* denotes one of the maxillæ of the first pair (our authors seem to describe this pair as the second); fig. *d* is no doubt a mandible. The left-hand figure of the two marked with a cross I take to be drawn from a preparation including portions of the first and second pairs of maxillæ in superposition; whilst the other figure with the same mark undoubtedly represents the upper lip with the clypeus, confounded by pressure into one mass*.

* In passing I may mention that the information given by Messrs. Spence Bate and Westwood on *Conilera cylindracea* proves unmistakably that its mouth is formed for biting, and entirely agrees with that of *Cirolani*, whilst differing widely from that of *Æga*, which, as I have shown in the former part of this treatise, is formed for suction. If, therefore, we are to be guided in our systematic arrangements by the structure of the mouth, and not merely by the general external resemblance (*habitus*), *Cirolani*, and with them *Conilera*, must not be classed with *Æga*, but removed to the opposite extremity of the series of *Iso-poda*. Having proved myself that *Æga* and *Cymothoa* are really sucking Crustacea, I quite agree with our authors when they place *Anthurus* next to them on account of the structure of its mouth: but this argument for their classification seems hardly consistent with their own statement (vol. ii. p. 273), that in “the second subtribe of the parasitical normal group of the *Iso-poda* [comprising *Serolidæ*, *Ægidæ*, and *Cymothoidæ*] the oral organs are formed for mastication.”

17. On examining the elongate head of the *Anthura* from beneath, after having separated it from the body, we observe at once a convex, broadly ovoid part situated in the middle, and reaching from the base so far forward as to occupy about half the length by nearly half the width of the entire head. At first sight one is tempted, by the shape and position of this piece, to take it for the stipites of the maxillipeds; but on closer examination it turns out to be immovably connected with the head all round; further forward the maxillipeds, too, appear developed in all their component parts; the ovoid protuberance must therefore be the prosternum, which thus in *Anthura* is distinguished by a very unusual size. The anterior margin of this large prosternum forms a transversal line, presenting a shallow sinus on either side, in which the cardo of the maxilliped is fixed, whilst the stipites of the maxillipeds fit through a kind of articulation into two deeper indentations in the middle of this same margin. The two maxillipeds lie so close together that the interior margin of the left stipes and of the first joint of the left palpus overlaps a little the opposite edge of the right stipes and of the first joint of the right palpus. In this way the two limbs together form an oblong duct, open above and reaching forward, almost on a level with the prosternum, to the base of the mandibular lobes. The first joint of the palpus has parallel sides and is one third longer than wide; the stipes is longer than the joint just mentioned, and at the apex of equal width with the latter; but its exterior margin is considerably dilated in the middle, while contracted near the base, in consequence of which a triangular space is left between the exterior margin of the stipes and the prosternum; and this space is filled by the triangular cardo of the maxilliped. In this manner the prosternum with the cardo, stipes, and first palpus-joint of each maxilliped form together a continuous whole, a sort of semi-cone projecting from the under surface of the head. With this other parts are combined. The second and last joint of the palpus of the maxilliped forms a small triangular leaf, the outer margin being convex, the inner margin concave; like the first joint, it is furnished with short sparse fine hair, a few longer and stronger setæ occupying the inner side. On account of this configuration, this joint does not approach closely to the corresponding one on the other side, but an elliptic slit is left between their interior margins, whilst their anterior, rounded margins touch closely on the upper lip. This latter hangs down almost perpendicularly from the large, conoid, strongly projecting clypeus; and its anterior margin presents a broad sinus. Taken together, all these parts con-

stitute a kind of semicylindrical tube, or short rostrum, placed under the head and proceeding from the prosternum, formed beneath by the closely joined maxillipeds, in front by the clypeus and the upper lip, and of which the elliptic opening is formed by the short terminal joints of the palpi of the maxillipeds. This semicylinder hides all the other organs of the mouth excepting the stipes and palpus of the mandibles. The palpi of the mandibles are triarticulate, and easily discovered; when at rest they are bent inwards and upwards against each other, so that their long, thin, pointed terminal joints appear close together in the cleft between the basal joints of the lower antennæ; a stronger magnifying power discloses that the whole palpus is covered with sparse, short, fine hair, like the palpus of the maxilliped, and that the elongate middle joint has three long and thick setæ on the under surface, whilst the terminal joint at the apex carries four incurved spines. But in order to find out the position of the stipes of the mandible, the head must be examined from the side. It is then observed that the lateral portions of the head, its pleuræ, present a longitudinal ridge reaching from the base to the fore end, passing just above the elliptic group of ocelli. The fore end of the pleuræ forms a protuberance between two deep sinuses—one above the ridge, for the first pair of antennæ, the other below the ridge, for the second pair of antennæ. The margin of the pleura is continued under the head in a curve, past the articular sockets of the second pair of antennæ, as far as a point opposite the apex of the stipes of the maxillipeds, ending there in a sharp indentation which opens outwards and upwards. The space bounded by this curved pleural margin and the first joint of the palpus of the maxilliped is occupied by the stipes of the mandible, which, however, only towards the apex comes close to the palpus, a space being left open at the base. The movement of the mandible is governed by the indentation just mentioned, which receives an articular protuberance of the mandibular stipes; but as the pleural margin overlaps a little the exterior margin of the latter, the movement of the mandible is, at any rate, very confined.

In order to obtain a correct idea of the other parts of the mouth, it is necessary to remove the maxillipeds, which hide them from below. If we succeed in doing so without disturbing the natural position of the organs, we observe the second pair of maxillæ with their straight inner margins closely joined together, so as to form an open duct with carinate bottom, somewhat contracted in the middle and with rounded apex. Their two lobes are short, flat, coniform, furnished with sparse

small warts, and curved inwards against each other; the two inner lobes are so short that they do not fill the space between the two outer ones, but a split is formed between the latter, corresponding in position to the middle of the opening between the terminal joints of the palpi of the maxillipeds. This second pair of maxillæ carries no palpus; it does not quite cover the first pair of maxillæ, but only their lobes, the stipes and cardo of the latter appearing on either side. When separated from the other parts, each maxilla of the first pair is seen to consist of a large, elongate triangular cardo, a very elongate, narrow, compressed-cylindrical stipes with contracted apex, and furnished in the midst with sparse short hair. The outer lobe is adnate to the stipes, narrow, hand-shaped, without spines, but divided on the inner side into seven long, pointed, somewhat incurved teeth, ranged in two rows, the lower one being formed by the long and stout terminal tooth, with the next following, which is more slender, and a small, slightly outward bent one in the inner corner, whilst the upper row is formed by four other teeth of middle size; there is no inner lobe nor palpus. When both these pairs of maxillæ are taken off, we perceive the tongue, which is flat, thin, naked, dilated, broadly rounded at the apex, and divided for more than half its length. The basal part of the split of the tongue is elliptically widened, and placed just over the middle of the opening between the maxillary lobes of the second pair, which again corresponds with the middle of the gap between the terminal joints of the palpi of the maxillipeds. Above the tongue, finally, the lobes of the mandibles appear. The outer one forms an irregular quadrangular or rather broadly falcate leaf, of which the anterior outer margin and the inner corner are somewhat thicker than the rest; the margin is rather rounded at the apex, and carries inside this, on the upper face, two broadly rounded flat teeth, one behind and above the other, giving the apex the appearance of being obtusely tridentate; the inner corner of the lobe forms a large, flat, coniform, somewhat recurved tooth. The thin, foliaceous inner lobe is fixed to the outer one, between the inner corner and the apex of the latter; its margin is curved and cut out into about twenty small recurved exceedingly sharp little teeth.

A comparison between the structure of the mouth of *Anthurus*, as just described, and that of Cymothoidæ discloses a general resemblance to that we have described in *Æga*, though there are differences in subordinate points. The sucking-tube is in both cases formed by the maxillipeds with the concurrence of the upper lip, which applies itself to them; but in

Anthura the palpus of the maxilliped has only two joints, and the stipes lacks the rudimentary lobe. The first and second pair of maxillæ are essentially of similar build; but in *Anthura* the latter are joined together in their whole length, and cover only the apices of the first pair of maxillæ. The lobes of the tongue are without the little digitiform prolongation which in *Æga* twists itself round the mandibular lobes. The stipes of the mandible is much shorter in *Anthura*; it is supplied with an articular protuberance; but its outer margin is overlapped by the margin of the pleura; the inner lobe is present and developed into a saw-blade; the terminal joint of the palpus is much longer than in *Æga*, and differently constructed.

As regards the totality of the oral organs and their mode of cooperation, *Anthura* differs from Cymothoidæ by the less elaborate equipment of the aperture of the sucking-tube; the upper lip has no fringes; and instead of a close armature of hooked warts the lobes of the second pair of maxillæ have only small conoid warts, and the palpi of the maxillipeds only carry some setæ. But the greatest difference is observable with regard to the manner in which the nourishment is made to flow into the oral tube, the scratching hooks of *Æga* and the lancet-blades of *Cymothoa* being in *Anthura* replaced by completely developed sawblades, viz. the inner lobes of the mandibles; when the apical teeth of the outer lobes have taken hold, these sawblades will be able to cut off extremely small particles, their movement against each other being regulated by the inner corners of the outer lobes, which project like teeth and prevent the inner lobes from crossing each other beyond the cutting parts of the sawblades.

The formula for *Anthura* will consequently be the following:—

Anthura.

Os haustellatum.

Haustellum adversum clypeo labroque, aversum maxillis posterioribus palpisque pedum maxillarium confectum, malas mandibulares serratorias maxillaresque priores rasorias involvens.

Clypeus obconicus, pendulus.

Labrum transversum, fornicatum, late emarginatum, pendulum.

Mandibulæ stipite depresso, amplo, trapezoideo, fixo, apice palpigero, malis binis. *Mala exterior* sub labrum oblique inflexa, mobilis, in orificium haustelli eminens, falcata, basi dentata, apice obtuse serrata. *Mala interior* cum mala priore concreta, laminata, acie arcuata, acute serru-

lata. *Palpus* labrum amplectens, triarticulatus, articulo terminali inter antennis primi paris recepto, producto, gracili, conico, apice spinoso.

Maxillæ priores stiliformes, *mala interiora* et *palpo* carentes.

Mala exterior cum stipite concreta, in orificium haustelli emincens, falcata, acie bifariam dentata, dentibus productis, incurvis, peracutis.

Maxillæ posteriores totæ contiguæ, malas maxillarum priorum obvolventes, cardine stipiteque concretis, palpo nullo.

Malæ discretæ, breves, conicæ, spisse verrucosæ, orificium haustelli supra palpos pedum maxillarum claudentes.

Pedes maxillares prosterno maximo, fornicato, ad medium caput protracti, maxillas utriusque paris includentes, cardine magno, obliquo, laminato, triangulo, malis nullis. *Stipites* contigui, recti, clavati, fornicati, hypostoma productum, medio carinatum utrinque expletes. *Palpi* biarticulati, latissimi, foliacei, fornicati, toti contigui, labia inferiora haustelli formantes.

Lingua laminata, nuda, biloba, lobis late rotundatis, introrsum contiguis, rimam suctoriam includentibus.

The Danish species of *Anthura* occurs rather near to the coast in shallowish water, where usually no other fishes than some species of *Gobius* and quite young flounders occur; specimens kept in captivity work about in the mud with serpentine movements. It does not therefore seem probable that our *Anthura* lives on fishes. At the same time, however, Spence Bate and Westwood conclude their article on *Anthura carinata* (ii. p. 162) with these words:—"The following vignette represents some fishermen drawing in a seyne full of fish, on most of which these crustacea attach themselves."

18. The study of the structure of the mouth in AMPHIPODA, as in Crustacea generally, has hitherto been directed towards the most pressingly necessary object—that is, the discovery of reliable marks for the distinction of the various divisions of these animals. For this purpose it has been sufficient to examine the outline and armature of the individual parts of the mouth; and in this direction many of the zoologists to whom we owe our present knowledge of Amphipoda have made valuable contributions, most of all Krøyer, whose diligent and conscientious investigations may be said to have opened a new era in the special study of this order. But in spite of many isolated attempts, this mode of working has not sufficed to procure us an insight into the true types of the structure. The method applied in the present series of investigations, viz. the study of the parts in their anatomical connexion and their

mode of cooperation, which depends upon the latter, has at present given me the following results.

The structure of the mouth in masticating Amphipoda presents three principal types, the connexions and mode of movement of the mandibles offering the best distinctive marks for them. To the *first type* belong the great bulk of those genera which are known as *Gammarina* and *Caprellina*, and which have been subdivided into numerous families according to their general appearance, and mixed up with Amphipoda presenting other types of oral structure. In reality, all those presenting this first type form one continuous series commencing with genera like *Gammarus*, having the body compressed, the epimera expanded into large branchial opercules, and a fully developed tail, from which we are gradually led on to the slender and cylindrical forms like *Caprella* and the flat form represented by *Cyamus*, having small or no epimera and more or less reduced tail—the modifications in the general form of the body being determined by the gradual substitution of an equipment for crawling and climbing in various combinations, instead of an equipment for jumping and swimming, and by a corresponding reduction in the size of the respiratory surface and the strength of the respiratory mechanism. With regard to Læmodipoda it must be observed, however, that Krøyer, in discussing the systematic rank of this division ('Naturhistorisk Tidsskrift,' iv. pp. 490–496), pays too little attention to the cardinal point to which Latreille attributes so much importance ('Règne Animal,' 1829, iv. p. 126), viz. that the second segment of the thorax is joined to the head, as well as the first segment, and that its limbs almost assume the character of maxillipeds.

It has been indicated already in the proper place, in the foregoing division of this treatise (Naturh. Tidsskr. 3 ser. iv. p. 177*) that the present series of Amphipoda entirely corresponds to the series of *Onisci* amongst Isopoda; but comprising, as it does, animals of more varied habitats than the latter, it is richer in modification of its type, and is in that respect most strikingly illustrated by comparison with several of those Ulonata, which amongst Insecta approach nearest to Crustacea, especially Mantidæ, Phasmidæ, Acridii, Locustidæ, and Gryllidæ, where we meet with quite corresponding series of forms, representing a corresponding gradual transition from flight to walking, and finally digging, as a condition of life.

The mandibles in this type are short, trilateral, with a broad triangular base, of which the outer corner with a short protu-

* Ann. & Mag. Nat. Hist. ser. 4, vol. i. p. 7.

berance fits into a socket in the pleural margin of the head; they have an oscillating movement, determined by this protuberance as a pivot and by the outer margin of the stipes. Those special arrangements for regulating the movements which will be described in the two other principal types are here wanting; and this series of Amphipoda might therefore suitably be described as *Eleutherognatha*.

In illustration of the combination which prevails among most of the *Gammarus-Caprella* type, we may take before us the structure of the mouth in *Caprella septentrionalis*, Kr. Looking at the head from the side, after having taken away the maxilliped with its strongly developed lobes and palpus armed with claws, we note first the flat and broad clypeus and upper lip; next, the epipharynx or palate, which forms a flatly rounded part in front of the opening of the pharynx; and finally, a portion of the lower lip, which appears between the mandible and the first pair of maxillæ, and which deserves particular attention as it plays a very important, hitherto overlooked, part in the mechanism of the mouth. A fuller view of it is obtained by examining the head from below, after removing all the appendages of the mouth except the mandibles, so that the hypostoma appears with the sockets in which the two pairs of maxillæ articulate; in front of these we then observe the same portions of the lower lip which we saw from the side, forming on each side a short horn, pointing backwards, and placed close under the stipes of the mandible, whilst the remainder of the lower lip, which is considerably developed, forms four cushion-like lobes round the orifice of the mouth. Two, of more oblong shape, are placed in front and extend laterally, whilst the two others, of obovate outline, are placed in the middle; but the bases of all point towards the mouth. The two foremost of these cushions fit very closely behind the mandibles; all four have a much smaller quantity of chitine and lime in their composition than the two horns of the lower lip above described; these therefore are stiffer than the cushions, yet yielding towards their outer extremity, and thus constitute a kind of spring, stiff enough to keep the mandibles up in the proper position for their oscillating movement, yet sufficiently elastic to yield to pressure when the mandibles are moved. We may, therefore, very properly describe these horns as *processus mandibularii labii inferioris*. The left mandible is somewhat stronger and more elaborately armed than the right one; both have a powerful and very prominent masticating process on the inner side, with elliptic rough crown, bearing inside the inner corner a single hairy filament. The broad transverse edge of the outer lobe is cleft into five

short prehensile teeth; the inner lobe consists of two parts, an anterior harder portion, with a serrate edge, and a posterior bundle of hairy membranaceous lobes, three on the left, two on the right mandible. The teeth of all four lobes are arranged so as to interlock, both the shape of the teeth and the torsion of the lobes towards the under surface and towards one another being accordingly somewhat different on the left and on the right mandible. The structure of the two pairs of maxillæ, the first pair with two lobes and palpus, the second pair with two lobes, has often been described.

19. The second type is met with in most of the Amphipoda known as *Lysianassa*, *Anonyx*, and *Opis*, placed together by Dana in a separate division under the name of *Lysianassina*.

The mandibles are here narrow and high. The pivot-and-socket arrangement behind is the usual one; but besides this we find, near the apex of the stipes on the upper side in front of the palpus, a club-shaped articular process, with rounded apex fitting into a corresponding acetabulum on either side of a saddle-shaped socket or mortise in the palate, close behind the upper lip, opening towards the mouth. The movement of the mandibles is therefore regulated, not only by the mandibular springs of the lower lip, which are here always present, but besides by the two articulations mentioned, one at either end of the outer margin. This kind of movement is in accordance with the peculiar structure and corresponding use of the outer lobes. These latter do not, as in the Eleutherognatha, form prehensile tongs armed with teeth, but powerful scissors, of which the short, edgewise-set blades cross each other, their cutting parts being wedge-shaped and furnished with an exceedingly sharp edge coated with enamel as hard as glass. With reference to this combination of structure, the Amphipoda of this series may be described as *Trochalognatha*.

As a specimen of this type we take the *Anonyx lagena*, Kr. Viewed from the side, the head presents especially this difference from the head of Eleutherognatha, that the upper lip forms a projecting hump, the mandibles are much higher and, instead of a pointed triangular outline, present a longer anterior margin slanting downwards; the mandibular springs of the lower lip are also considerably longer. If we examine the head from below, after having removed the antennæ and the appendages of the mouth except the mandibles, we observe still better the peculiar shape of the thick protruding upper lip, of which the lower margin even forms a separate thicker wall or bolster. This latter covers the upper corners of the mandibular scissors, of which the left blade, furnished with a bifurcate prehensile hook in the lower corner, glides on

the upper face of the right-hand blade, on which the prehensile hook is undivided and extremely finely pointed. The foremost lobes of the flat lower lip are thin and pointed; the middle lobes are roundly emarginated in front, leaving a part of the palate in front of the pharynx uncovered; the mandibular springs, on the contrary, are somewhat dilated and very stiff. If we then proceed, by taking away the upper lip and folding the entire lower lip back from the hypostoma, we observe the grinding-teeth of the mandibles, which before were covered by the middle lobes of the lower lip. In shape and structure they are peculiar, being elongate, narrow, flat, and scarcely touching each other with their crowns, which are only armed with setæ, and show a very small terminal surface. Taking, moreover, into consideration the peculiarly restricted mode of movement of the mandibles, we cannot fail to perceive that in this case they are employed rather for the purpose of carding the food and pushing it into the pharynx than as grinding-teeth. The explanation of this arrangement and of the heavy proportions of the upper lip presents itself if we examine more closely the structure of the palate, whereby it will appear, in the first place, that without the strong development of the upper lip the necessary space and support would be wanting for the articular eminence of the mandible, which in Trochalognatha is fitted into the palate; in the second place, a portion of the palate just behind the mortise for the articular process of the mandible will attract notice, being triangular, somewhat lower than the rest, with sharply defined sides, analogous to the velum palatinum of Mammalia, and carrying a small pendent flap with rounded apex, a kind of uvula, which reaches beyond the anterior margin of the pharynx. To the sides of this velum palatinum the grinding-teeth of the mandibles are closely joined; and the whole of their form is arranged to fit in with it. It is therefore evident that, as above stated, they can play no other part than that of carding the food and pushing it into the pharynx.

Amongst the other appendages of the mouth, the second pair of maxillæ and the maxillipeds offer no essential difference from those of Eleutherognatha; but the first pair of maxillæ are distinguished by the following peculiarities:—the terminal joint of the palpus is dilated, hollowed into the shape of a narrow cup, with broadly truncate apex armed with short coniform spines; the outer lobe has very powerful pectinate spines, whilst the inner lobe is very small, with only two hairy and membranaceous appendages.

Amongst Crustacea there exists one other Trochalognathe group; but it is in another order, namely Chilopoda amongst

Myriopoda. The protuberance by which their mandibles articulate with the palate has been observed by Latreille (*Règne Animal*, 1829, iv. p. 335), but he describes it as "un petit appendice en forme de palpe." Dr. Meinert, however, has rightly interpreted it as an articular condyle in his paper, "Myriapoda Musæi Hauniensis" (*Naturhist. Tidsskr. ser. 3, vii. p. 11*, and the first note).

The Trochalognathe Amphipoda form a closely grouped division, with only two principal types, *Lysianassa* (or *Anonyx*) and *Opis*; but recent authors on the English and northern fauna, especially Spence Bate, Westwood, and Axel Boeck, have subdivided them into a great number of small genera. The differences as to the shape and armature of the oral limbs are insignificant, and mostly indicated already in Krøyer's careful description of the northern species (*Naturhist. Tidsskr. ser. 2, i. and ii.*), and in his figures in the great French work 'Voyages de la Commission scientifique du Nord en Scandinavie, en Laponie, au Spitzberg et au Ferö pendant les années 1838-1840 sur la corvette la Recherche,' *Crustacés*, pls. 13-18. He has in several instances observed the condylus palatinus of the mandible, describing it as a "conic prolongation of the grinding-tooth;" the varying length of that piece in front of the palpus which carries the condyle is expressed by him and later authors by saying that the palpus is inserted more or less forwardly on the mandible. He indicates, furthermore, correctly the different development of the lower corner of the outer lobe, as well as that the terminal face of the grinding-tooth in most species is somewhat larger than in *Anonyx lagena*, often transversely grooved, and furnished with short pectinate appendages. Finally, Krøyer has had a true estimate of the systematic connexion between these Amphipoda: he says (*l. c. ii. p. 55*), "The genera *Anonyx* and *Opis* appear to me to offer so many differences from the ordinary type of Amphipoda as expressed in *Amphithoë*, *Gammarus*, &c., that in my opinion they might properly form a separate little group or subfamily in this order."

Just as the Eleutherognathe Amphipoda correspond to Onisei amongst Isopoda (the term Onisei being understood as defined in the former part of my paper, vol. iv. p. 183*), thus the Trochalognathe Amphipoda correspond exactly to *Cirrolana* as characterized in the same place. Their habit of working about in the sand of the bottom, their power and endurance in swimming, their savage behaviour even to one another, their voracity as carrion-eaters, and the part which

* *Ann. & Mag. Nat. Hist.* 4 ser. i. pp. 7, 8.

they must play in this respect by their enormous quantity on the coasts of Greenland have been described by Captain Holböll in several contributions to Kröyer's treatises. In one place he says, "By letting down a basket containing a dead raven and a piece of the head of a shark to a depth of 75 fathoms, I have, in the course of two hours, got more than six pints of these small animals, although the basket was open and left a broad stream of animals, like a swarm of bees, that escaped during the hauling-up of the basket" (Naturh. Tidsskr. iv. p. 143). In another place the following occurs:—"The larger species of this genus (*Anonyx*) are so voracious that they do not cease eating, even if the food is taken out of the water. If several are confined together in a vessel they soon eat one another" (*ibid.* 2 ser. ii. p. 55).

[To be continued].

BIBLIOGRAPHICAL NOTICE.

Monograph of the Asiatic Chiroptera, and Catalogue of the Species of Bats in the Collection of the Indian Museum, Calcutta. By G. E. DOBSON, M.A., M.B., F.L.S., &c. 8vo. London: 1876.

A FEW months ago we published in this journal a sketch of a new classification of Bats by the author of this work, a classification which, without departing very widely from the groupings of previous authors, certainly seems to bring the whole arrangement of these animals into a particularly intelligible form. As a reprint of the article above referred to constitutes the general introduction to the 'Monograph of Asiatic Chiroptera,' it need not be specially noticed here.

The chief characteristic of the new classification consists in the recognition, in accordance, apparently, with the doctrine of evolution, of a sort of parallelism in the families of the insectivorous Bats (*Microchiroptera* of Dobson)—the simple-nosed Vespertilionidæ and Emballonuridæ (better, perhaps, Noctilionidæ) leading respectively from supposed unknown ancestral forms to the Nycteridæ (*Megadermata*) and Rhinolophidæ on the one hand, and to the Phyllostomidæ on the other, the Pteropidæ being regarded (and, we think, with reason) as representing a distinct type or line of development. It is particularly interesting to find that the discrimination of these two alliances (or lines of descent) is confirmed by so minute a character as the microscopic structure of the hair—the members of the "Vespertilionine alliance" (Vespertilionidæ, Nycteridæ, and Rhinolophidæ) having the superficial scales of the hairs imbricated, while those of the "Emballonurine alliance" (Emballonuridæ and Phyllostomidæ) have them whorled and generally acute and projecting; but we cannot understand how Mr. Dobson can regard the hair of the